U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Lighting the Classroom of the Future

LightFair

June 5, 2014

Bob Davis & Andrea Wilkerson

Pacific Northwest National Laboratory

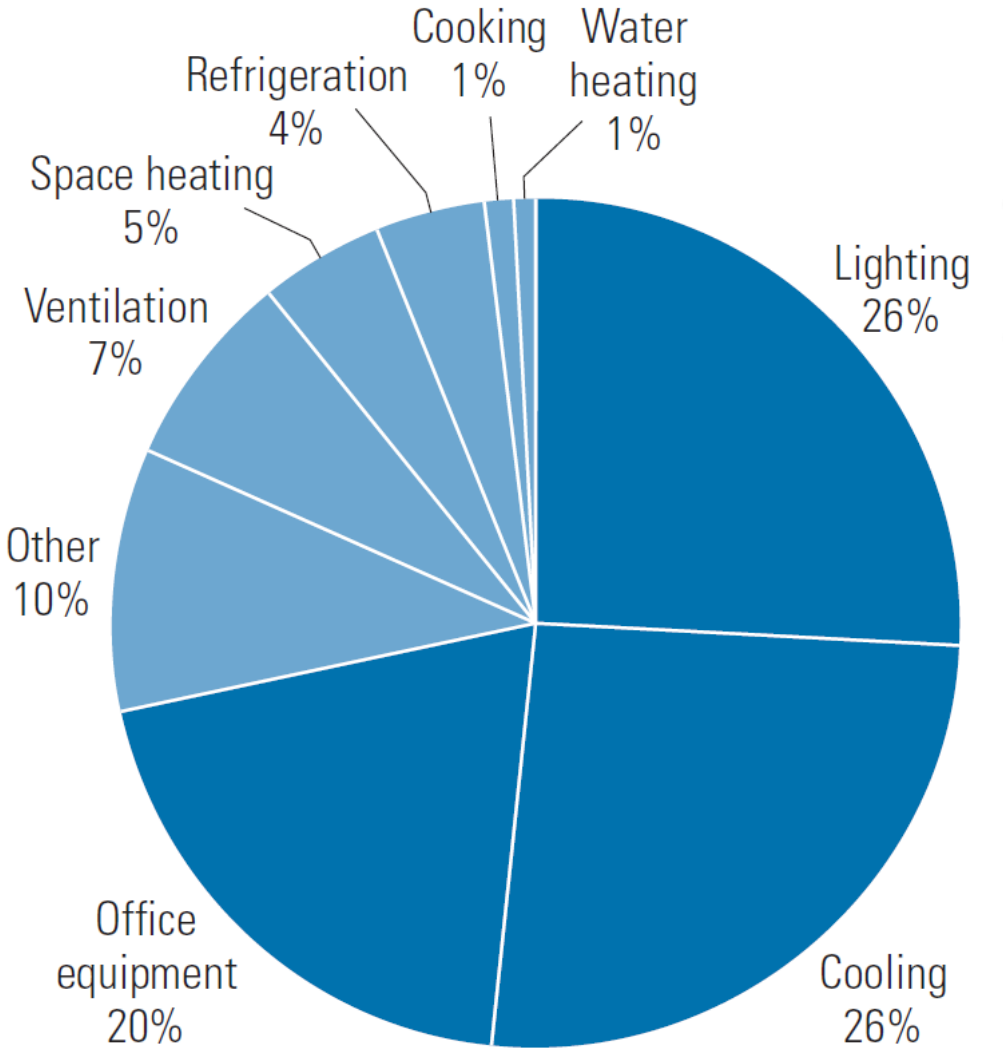
Lighting the Classroom of the Future

DRIVING FORCES

- Classroom lighting is a major energy use
- Classroom design is changing rapidly

How can lighting respond to these forces?

Typical K-12 School Electricity Use



Nationally **16 GWh** per year for classrooms!

85% Linear Fluorescent
10% Compact Fluorescent
2010 Lighting Market Characterization, US DOE

Schools spent **$130**/student for electricity in 2005.
2006 Energy Star Building Manual 10, K-12 Schools

Energy Information Administration, CBECS, **1999 and 2003 data**

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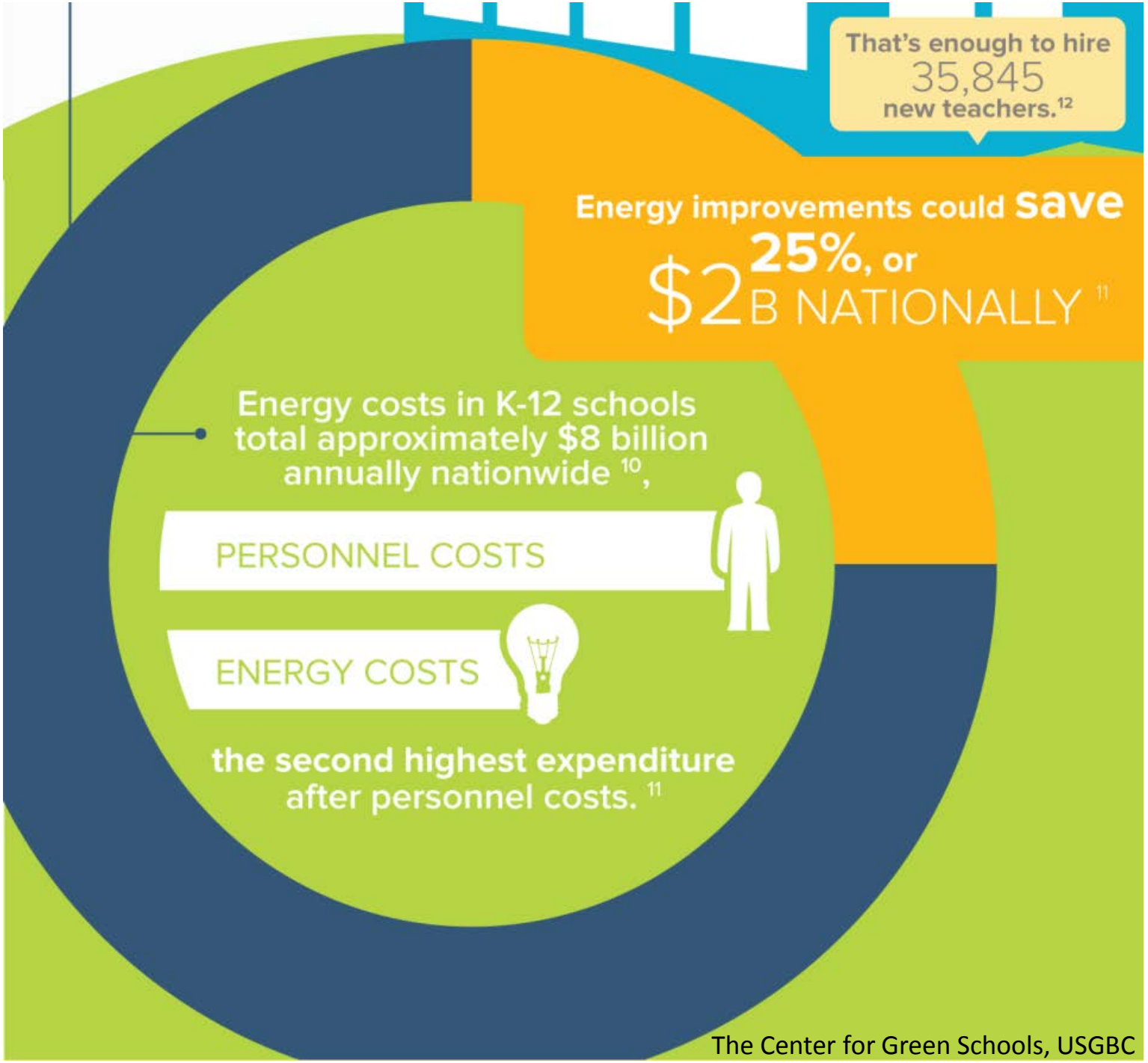
2014



The Center for Green Schools, USGBC

Lighting the Classroom of the Future

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Trends Affecting Classroom Lighting

Trend 11: Technology Becomes the Future: The Future Becomes Technology

Trend 15: By Necessity Learning Evolves to an Asynchronous and Ubiquitous Process

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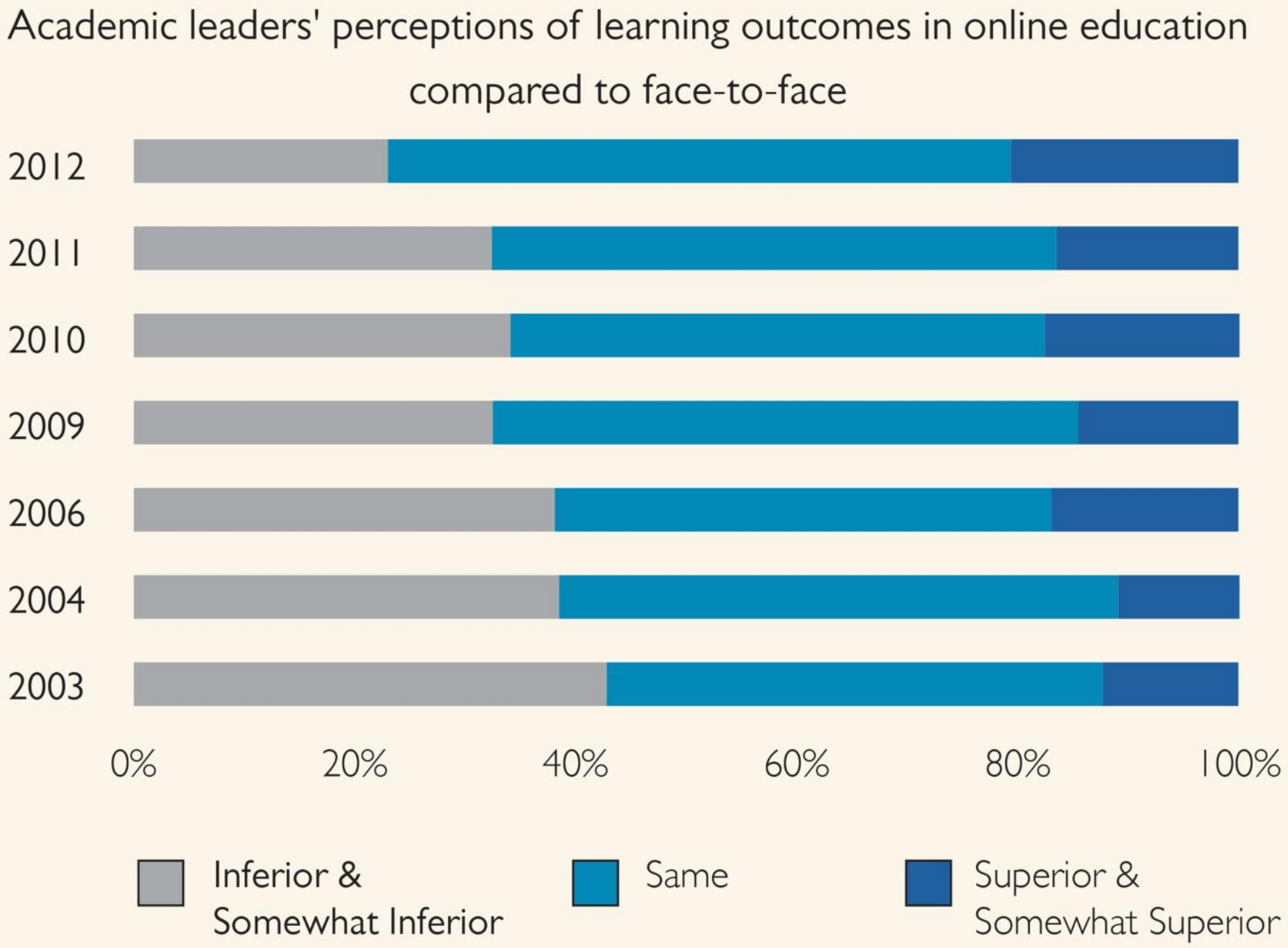

2013 Changing Course Survey – Pearson: Babson Survey Research Group, Pearson and Quahog Research Group

OSU Classroom Building

boora architects

Firefox

Classroom Building | OSU Webcams | Or...

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OSU Webcams - Classroom Building

Classroom Building

Classroom Bldg 2014-06-04 17:36:15

If video image does not work, view the static image

About

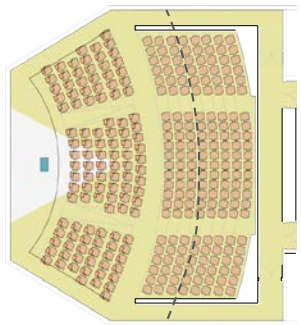
OSU's newest classroom building will be a four-story, technology-rich learning environment, hosting over 2000 classroom seats in state-of-the-art classrooms including arena- and parliament-style lecture halls. The building will be home to the Integrated Instructional Resource Center (IIRC), Media Services, and the University Honors College (UHC), and will otherwise be open for use by all departments on campus.

Construction Time Lapse

Daily Time Lapse

6/3/2014	5/27/2014
6/2/2014	5/26/2014
6/1/2014	5/25/2014
5/31/2014	5/24/2014
5/30/2014	5/23/2014
5/29/2014	5/22/2014
5/28/2014	5/21/2014
	5/20/2014

PROGRAM
CLASSROOM VARIETY



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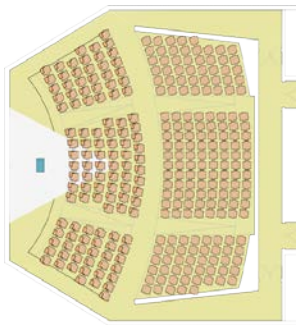

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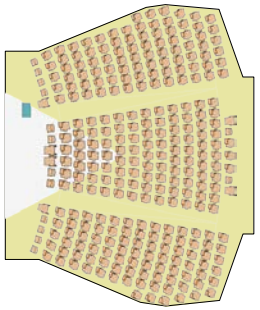

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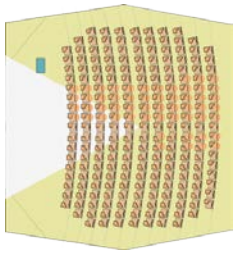

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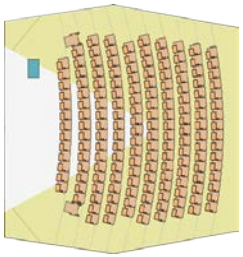

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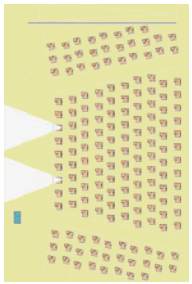

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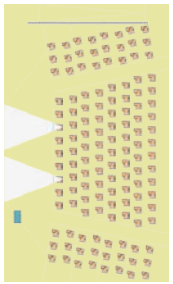

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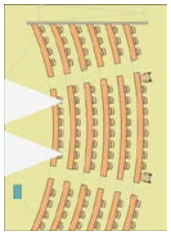

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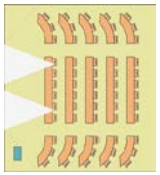

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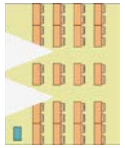

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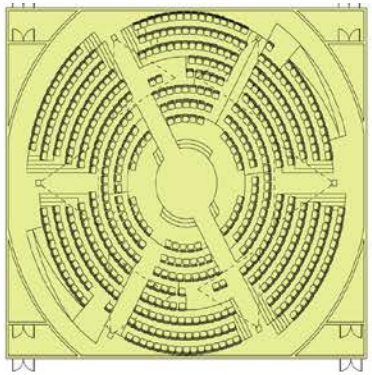
BUILDING PROGRAM — FORMAL LEARNING PROGRAM



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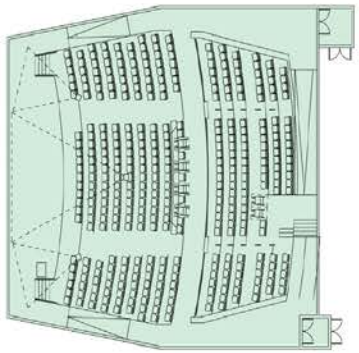

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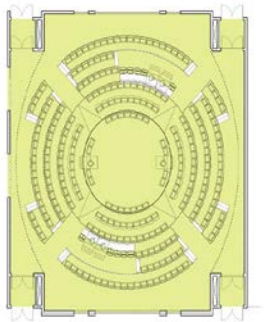

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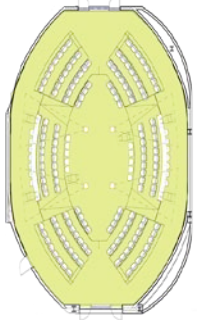

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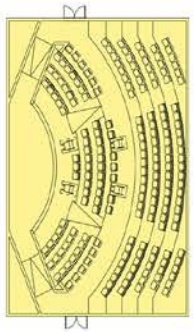

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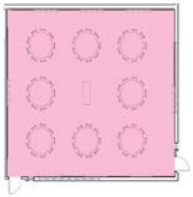
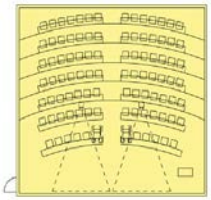


72-90



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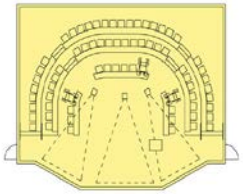
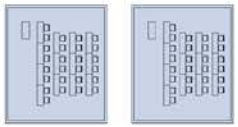


70

60-89

14
honors



26-40
honors

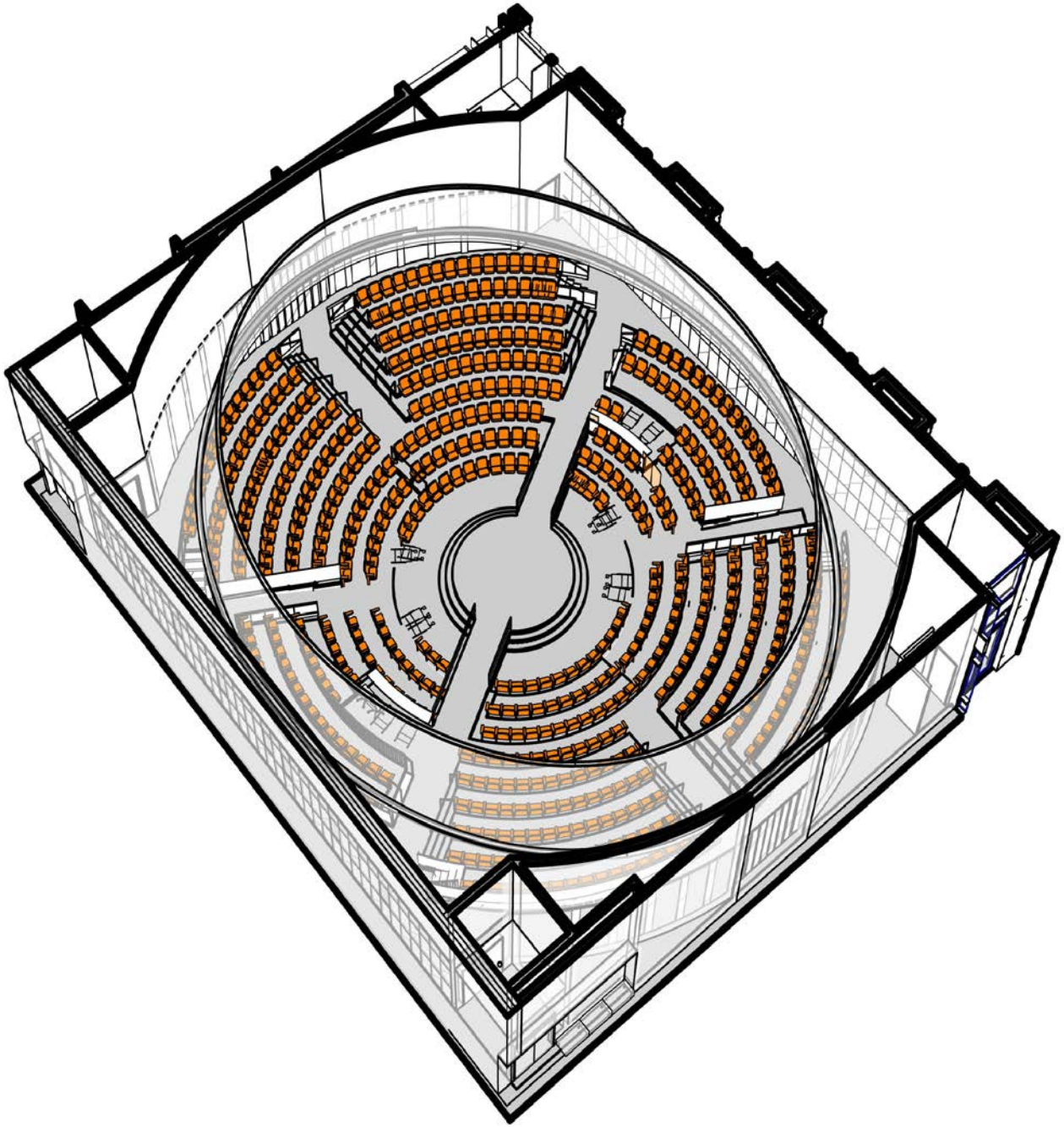
29-42
IIRC

2145-2270 Classroom Seats

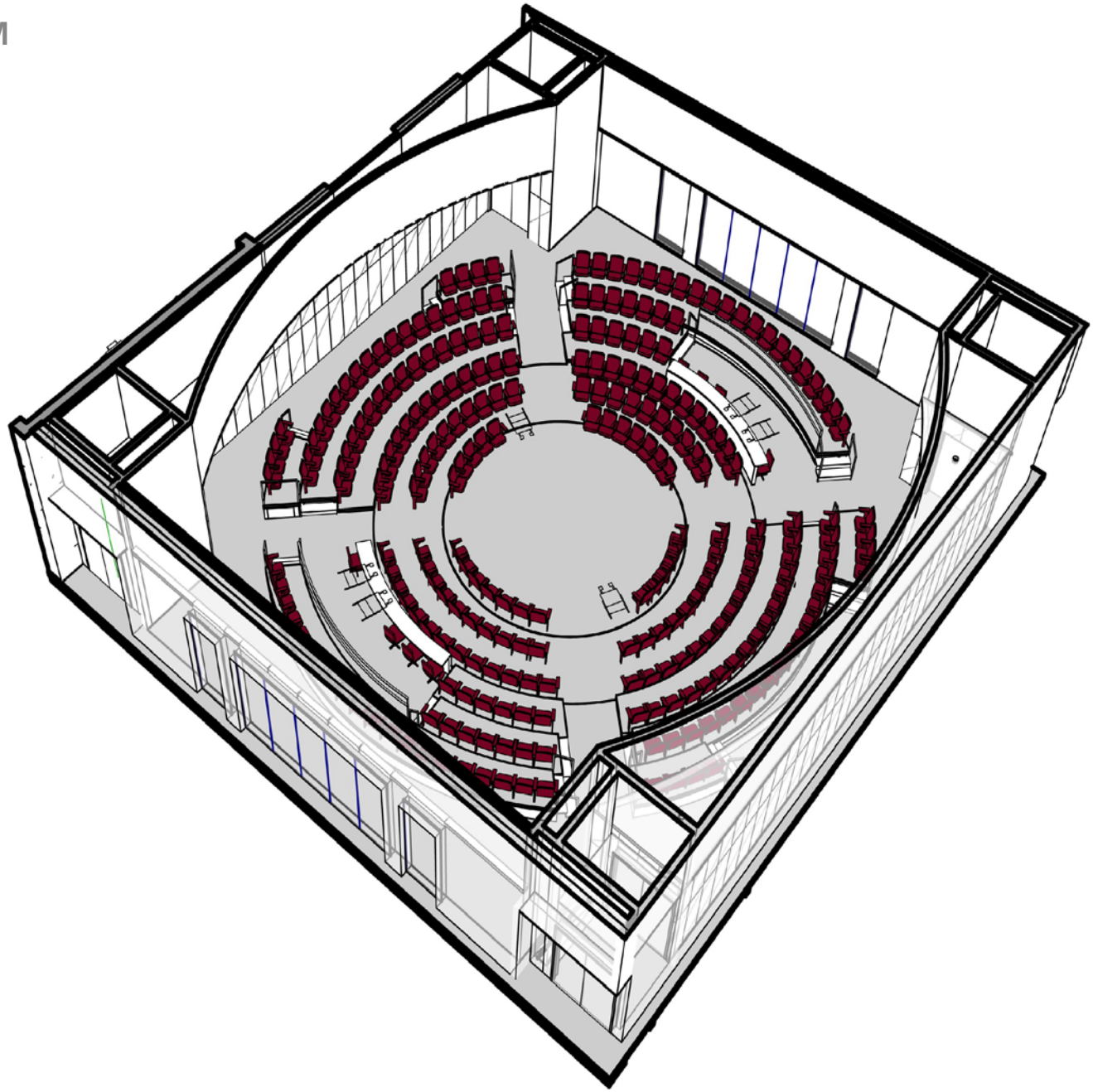
Integrated Instructional Resource Center Offices/Facilities

University Honors College Offices and Study Lounges

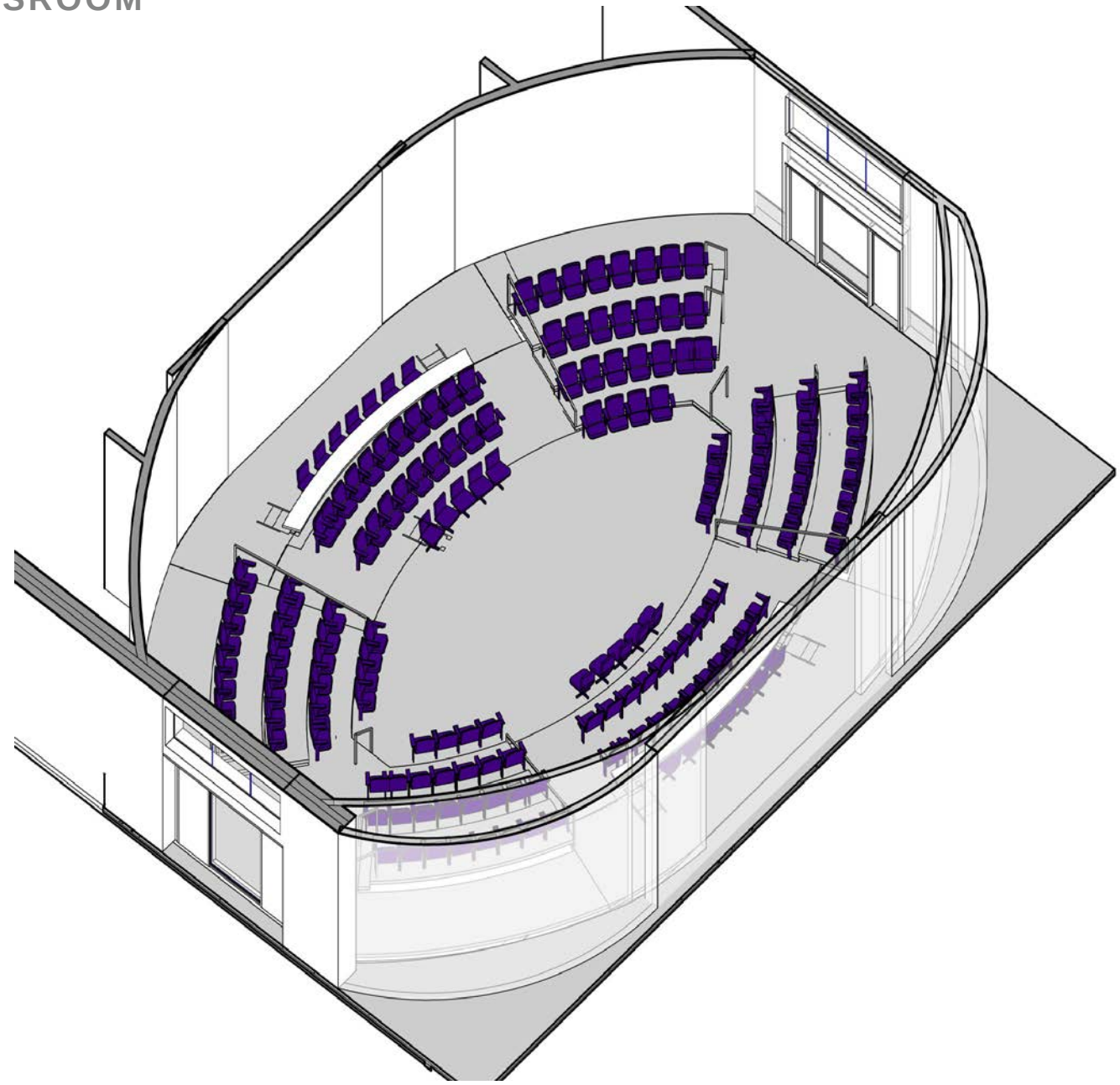
ARENA CLASSROOM

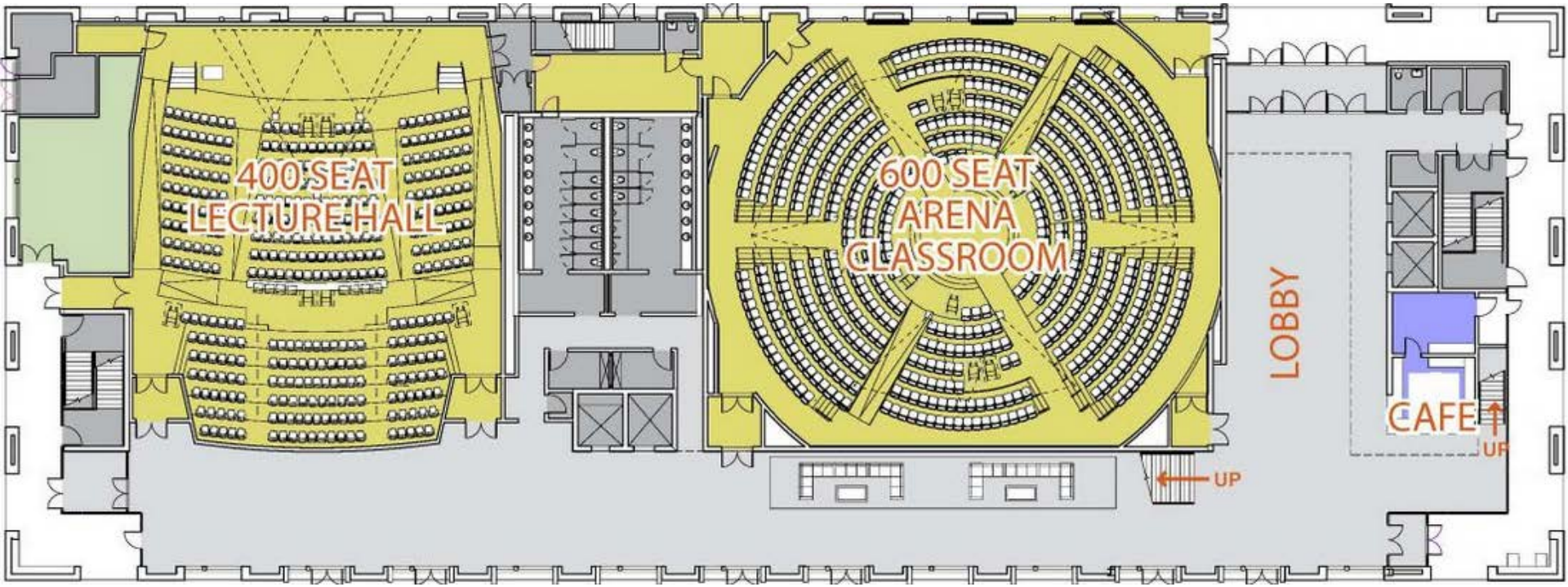


SMALL ARENA
CLASSROOM



PARLIAMENT CLASSROOM





boora architects

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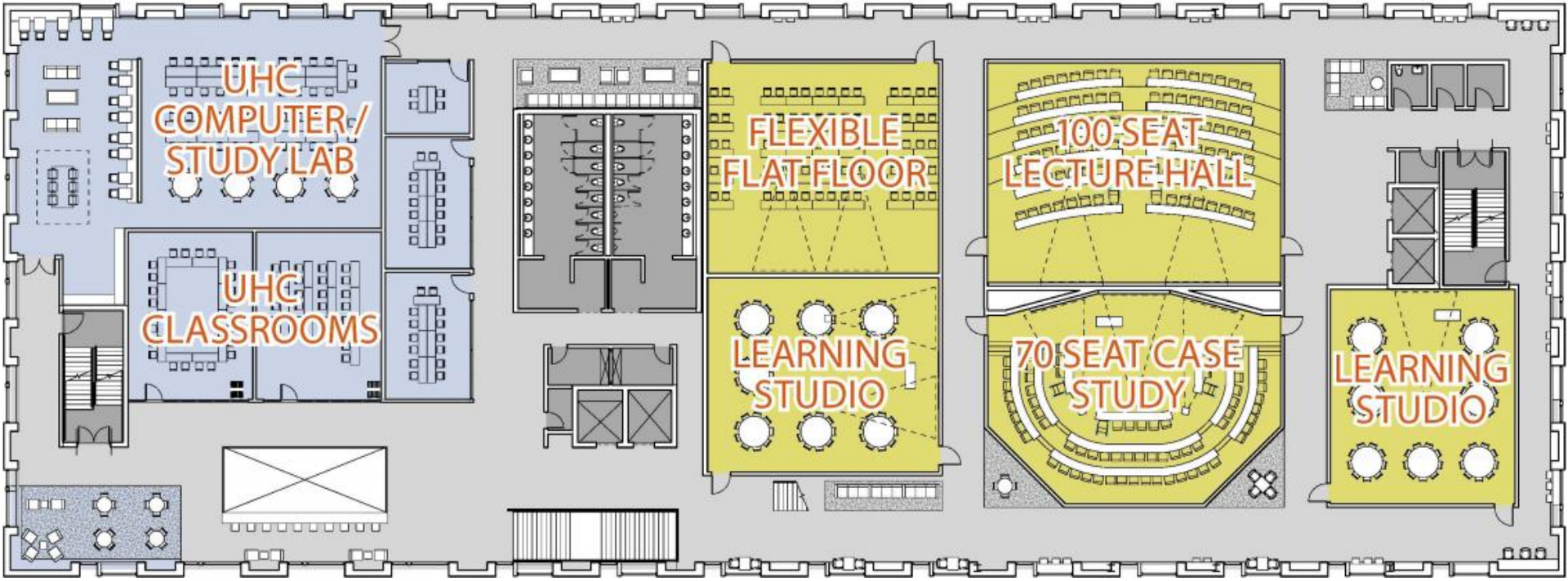

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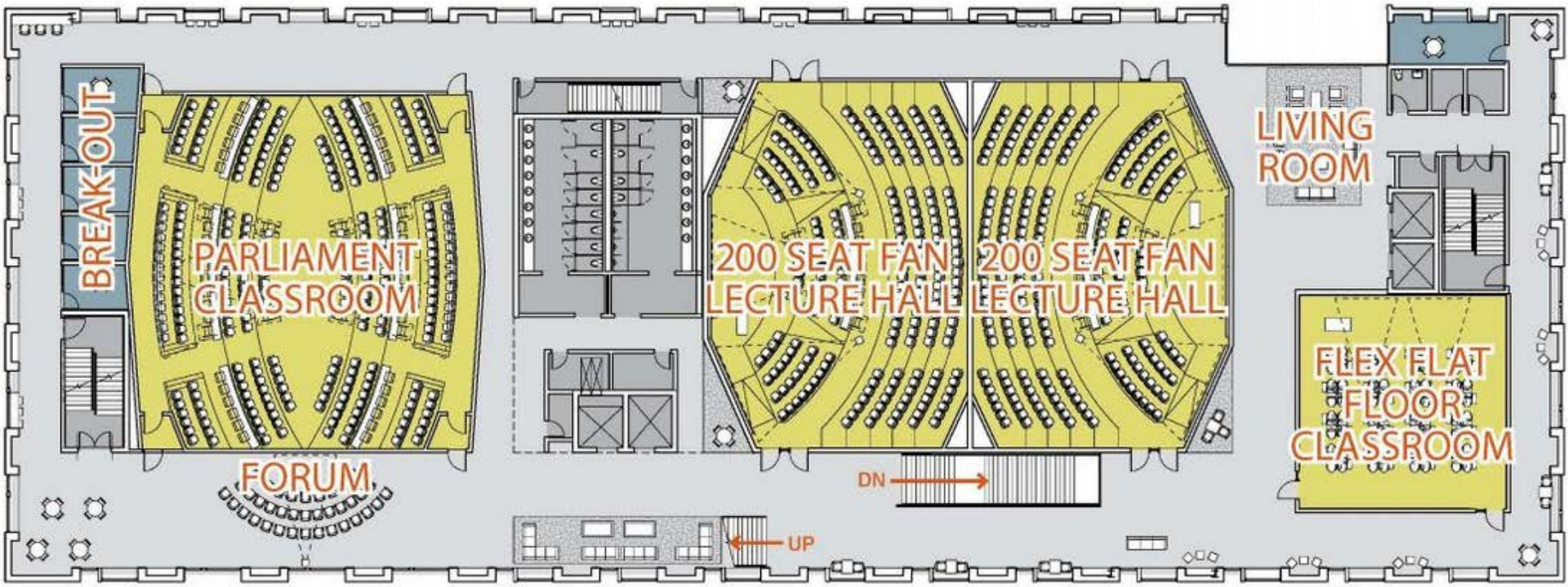

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DRIVING FORCES

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How can lighting respond to these forces?

Lighting the Classroom of the Future

Let’s imagine a day in the life of

a future classroom . . .

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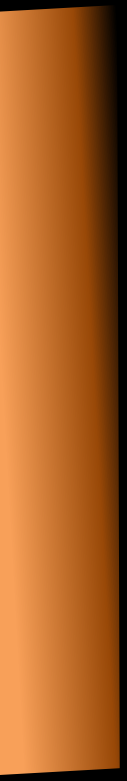
6:00AM CLASS NOT IN SESSION

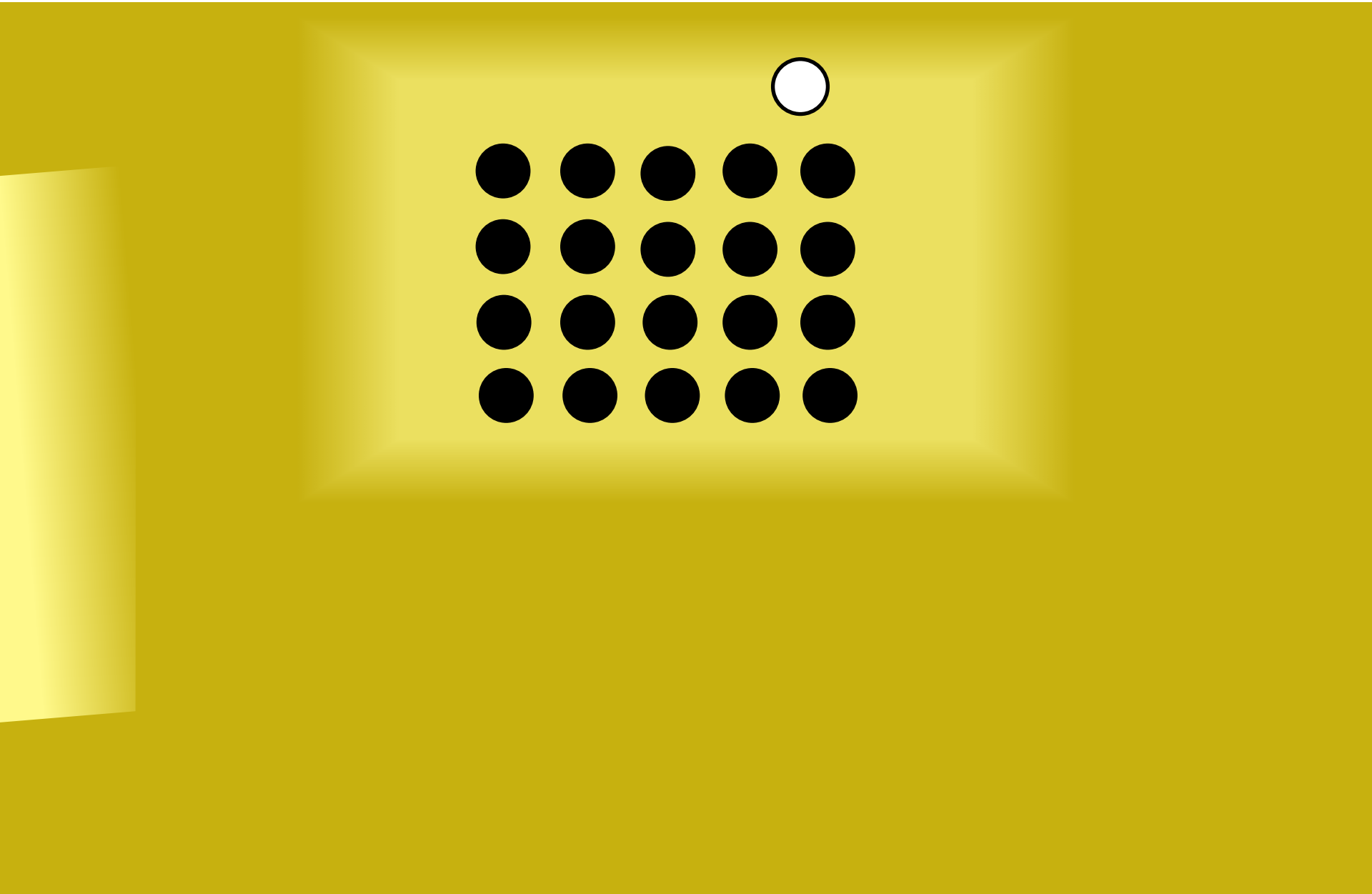
LECTURE	TEAM-1	TEAM-2	TEAM-3	PROJECTION AREA
0	0	0	0	0



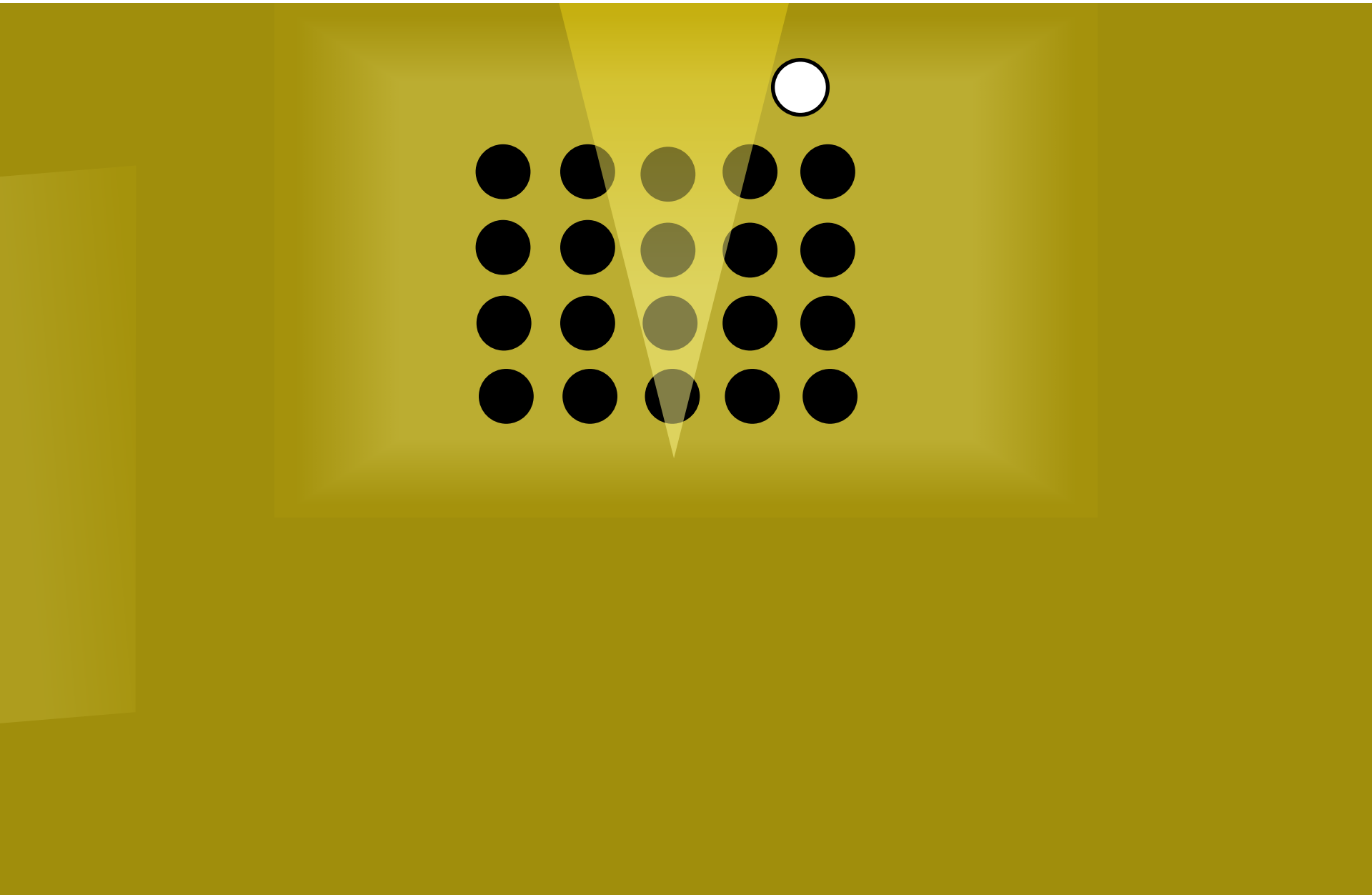
8:15AM CLASS IN SESSION – LECTURE

LECTURE TEAM-1 TEAM-2 TEAM-3 PROJECTION AREA

400 100 100 100 300

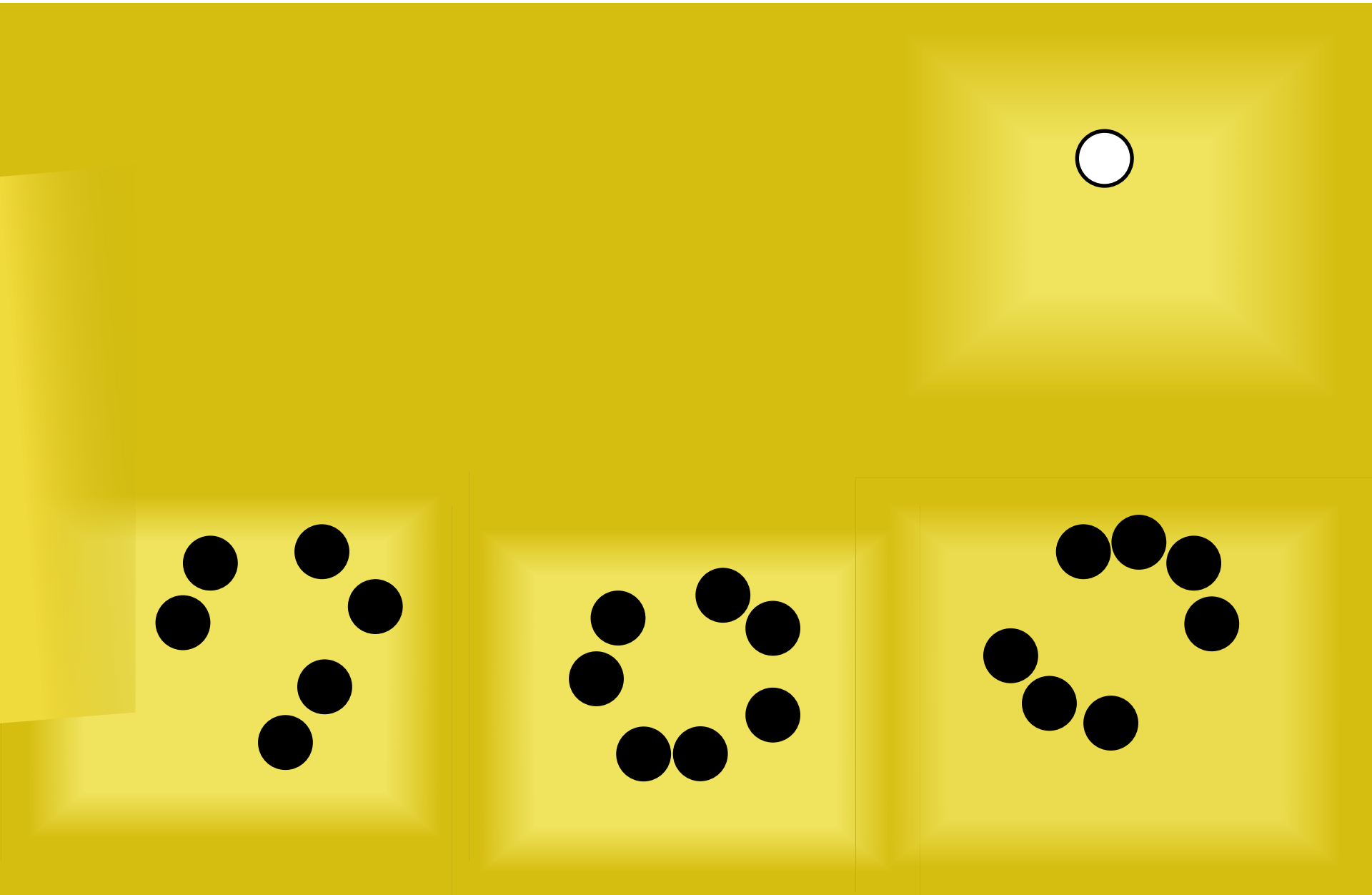


8:30AM CLASS IN SESSION – PROJECTOR PRESENTATION



8:45AM CLASS IN SESSION – GROUP WORK

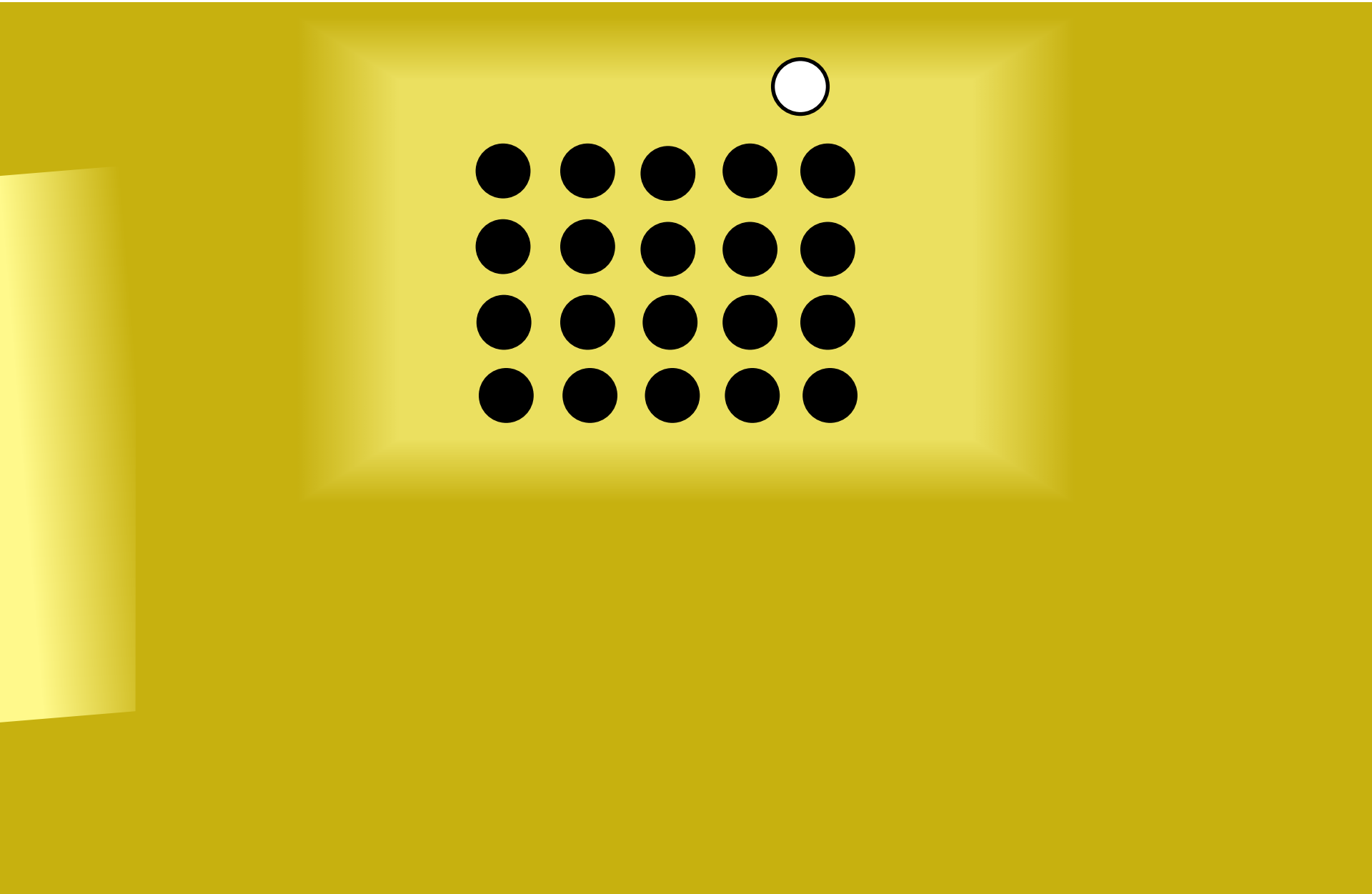
LECTURE	TEAM-1	TEAM-2	TEAM-3	PROJECTION AREA
100	250	300	300	30



9:15AM CLASS IN SESSION – LECTURE

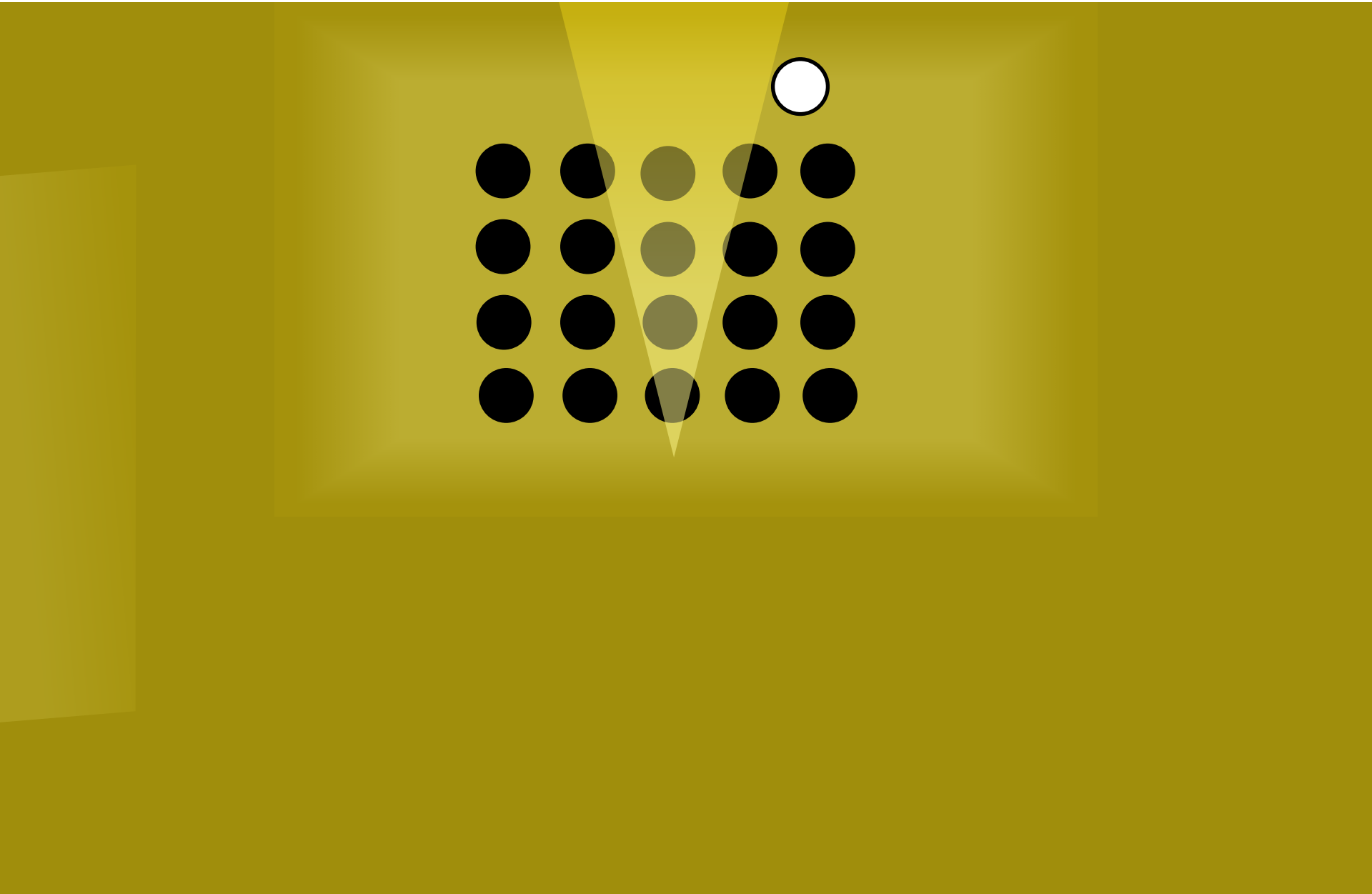
LECTURE TEAM-1 TEAM-2 TEAM-3 PROJECTION AREA

400 100 100 100 300



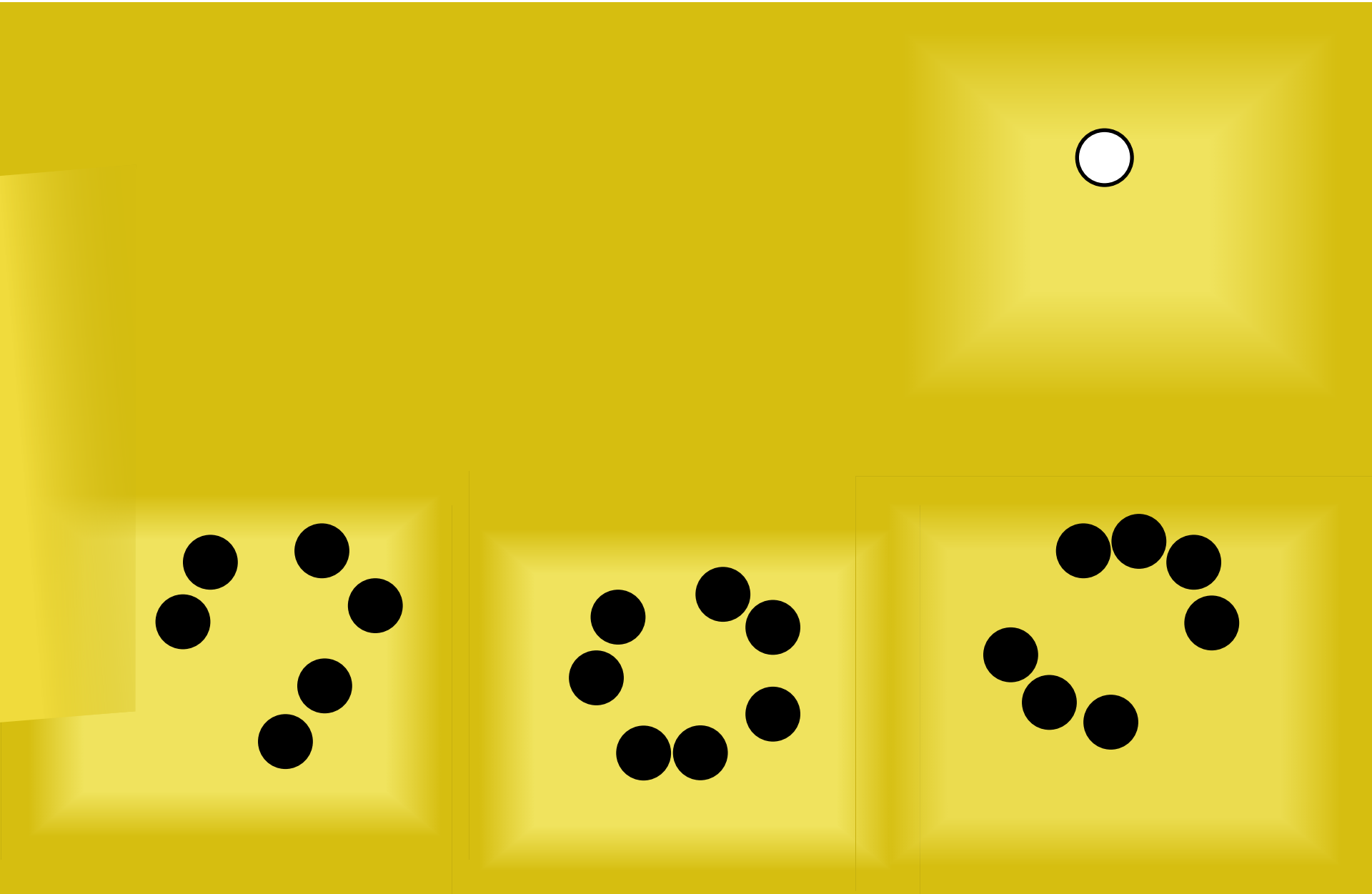
9:30AM CLASS IN SESSION – PROJECTOR PRESENTATION

LECTURE	TEAM-1	TEAM-2	TEAM-3	PROJECTION AREA
200	30	30	30	50



9:45AM CLASS IN SESSION – GROUP WORK

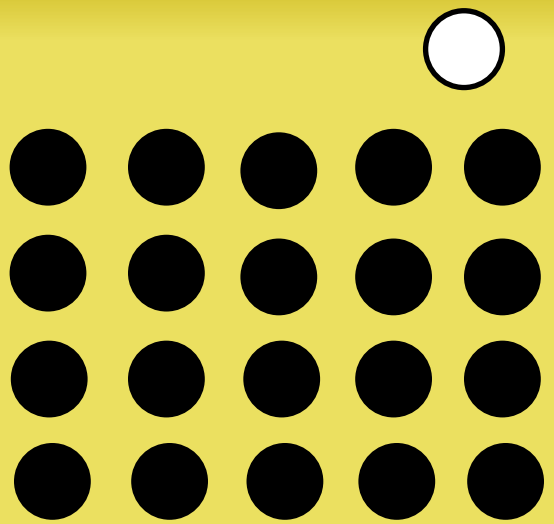
LECTURE	TEAM-1	TEAM-2	TEAM-3	PROJECTION AREA
100	250	300	300	30



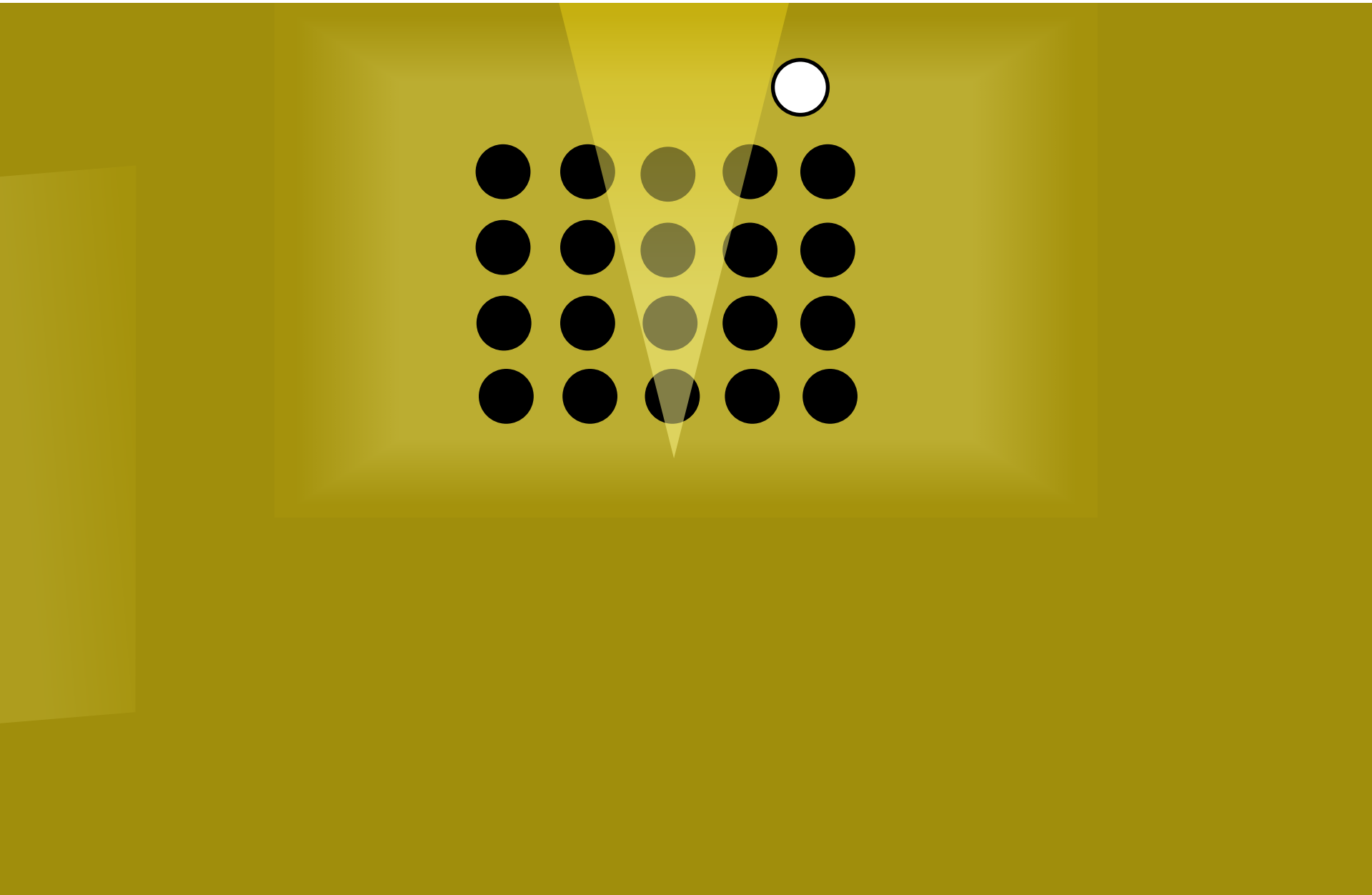
10:15AM CLASS IN SESSION - LECTURE

LECTURE TEAM-1 TEAM-2 TEAM-3 PROJECTION AREA

400 100 100 100 300

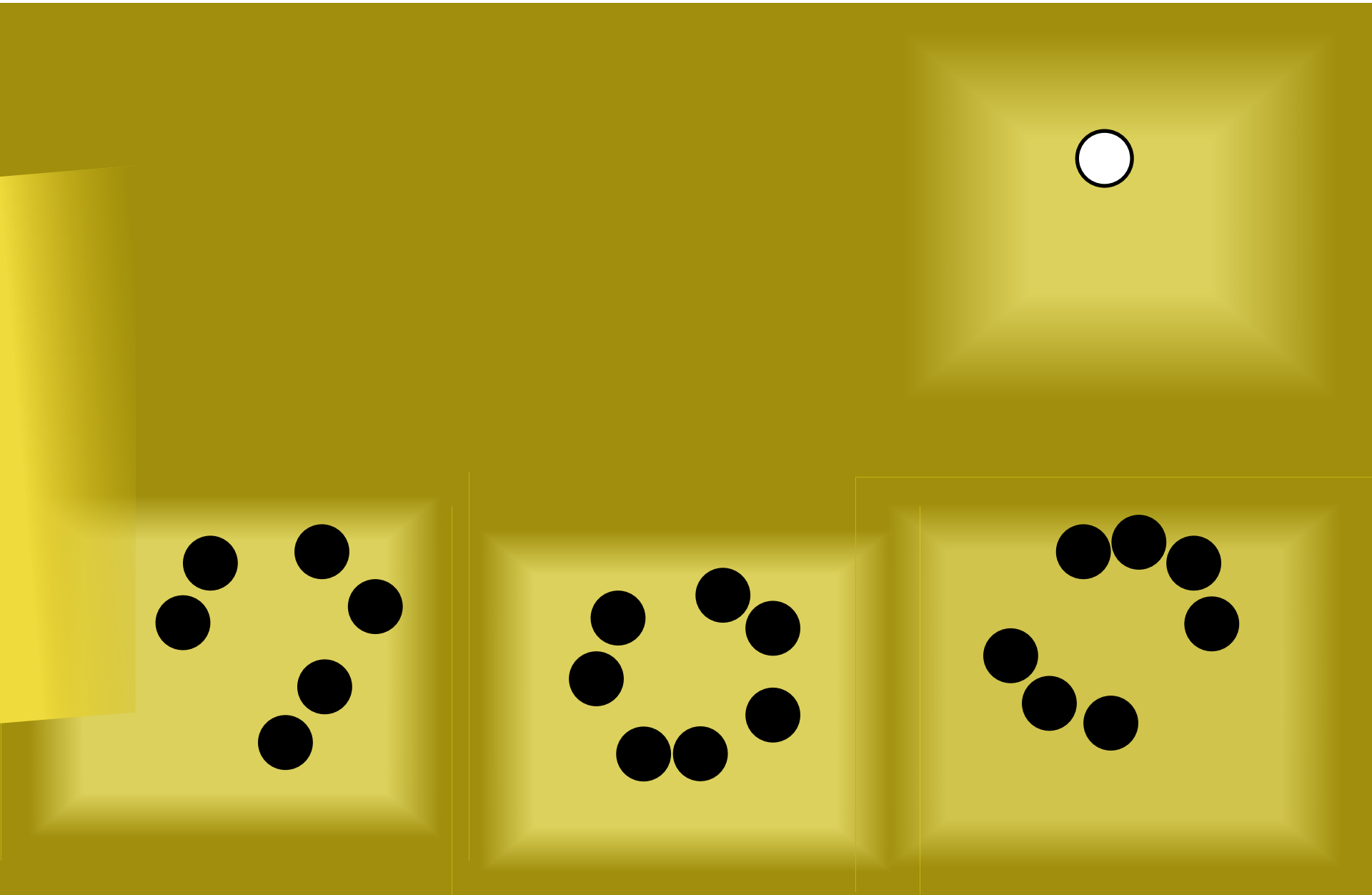


10:30AM CLASS IN SESSION – PROJECTOR PRESENTATION



10:45AM CLASS IN SESSION – GROUP WORK

LECTURE	TEAM-1	TEAM-2	TEAM-3	PROJECTION AREA
100	250	300	300	30

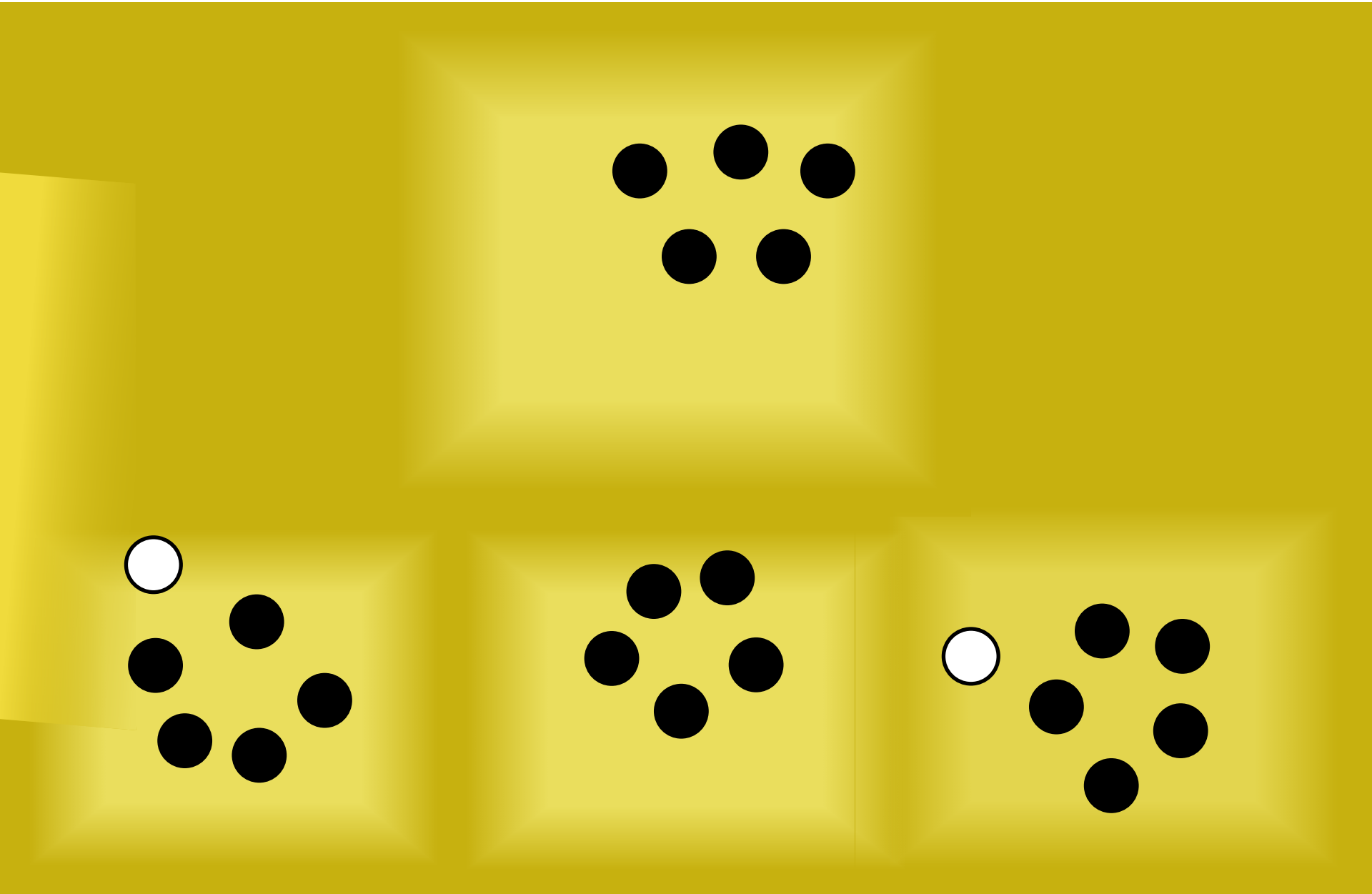


11:30AM LUNCH – UNOCCUPIED

LECTURE	TEAM-1	TEAM-2	TEAM-3	PROJECTION AREA
0	0	0	0	0

12:30PM CLASS IN SESSION – GROUP WORK

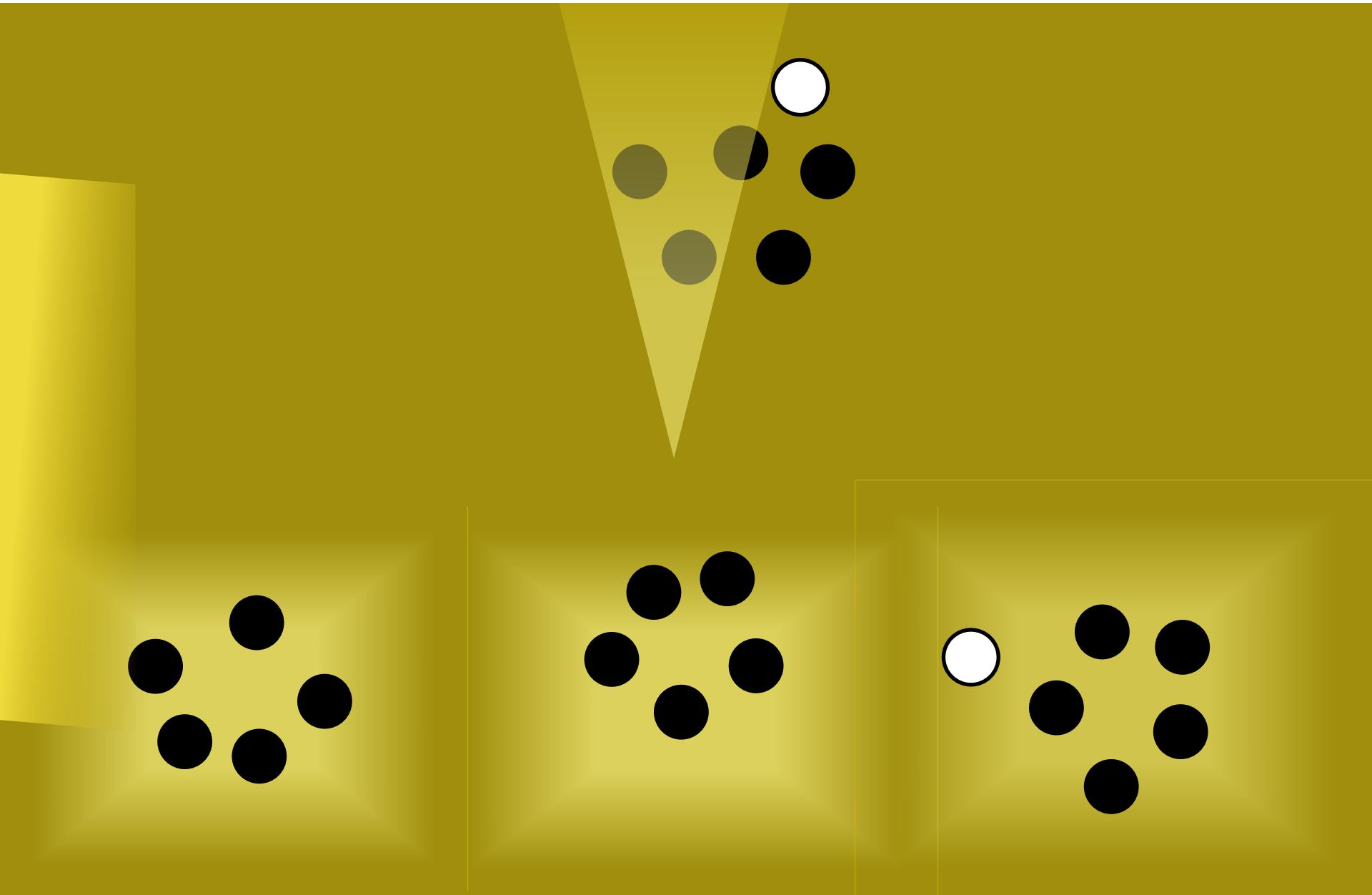
LECTURE 300 | TEAM-1 250 | TEAM-2 300 | TEAM-3 300 | PROJECTION AREA 50



12:45PM CLASS IN SESSION – GROUP WORK

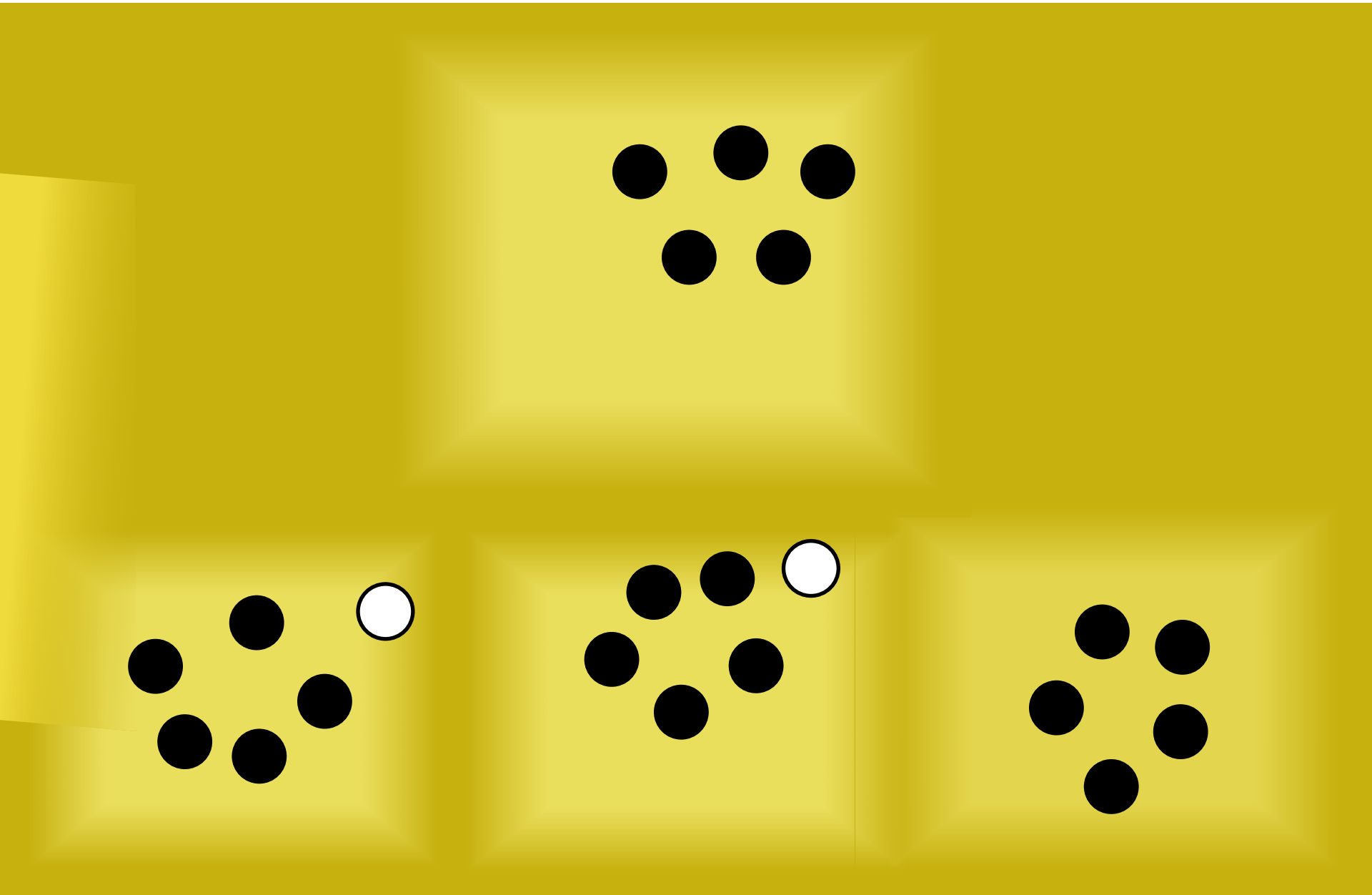
LECTURE TEAM-1 TEAM-2 TEAM-3 PROJECTION AREA

100 200 200 200 30



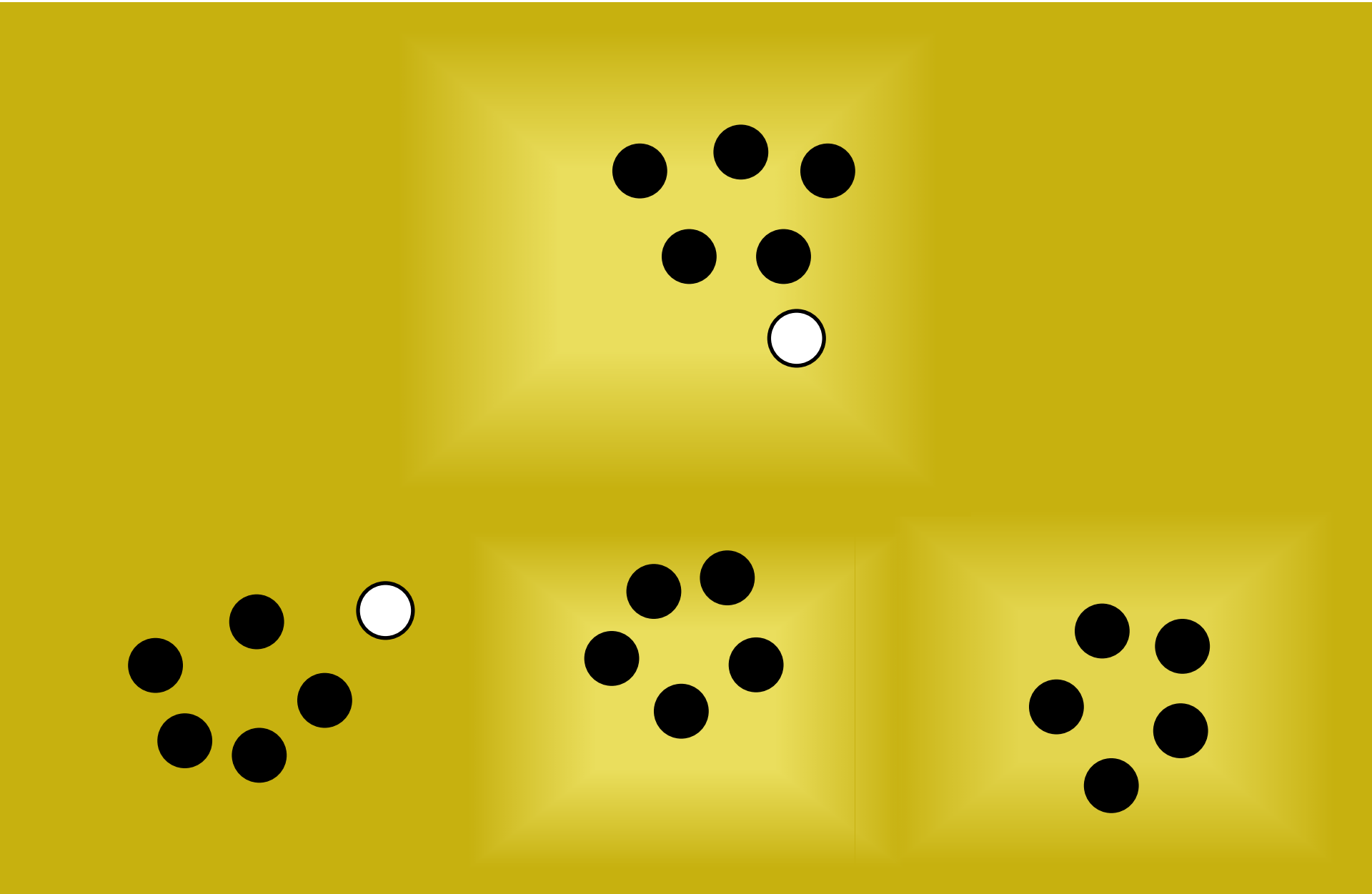
12:50PM CLASS IN SESSION – GROUP WORK

LECTURE 300 | TEAM-1 250 | TEAM-2 300 | TEAM-3 300 | PROJECTION AREA 50



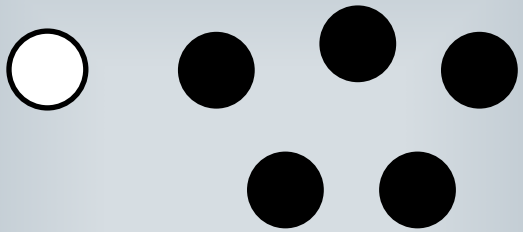
12:55PM CLASS IN SESSION – GROUP WORK

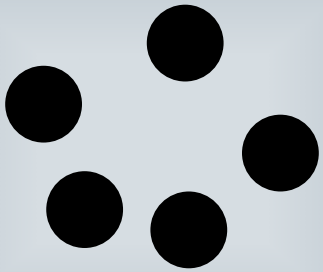
LECTURE 300 | TEAM-1 50 | TEAM-2 300 | TEAM-3 300 | PROJECTION AREA 50

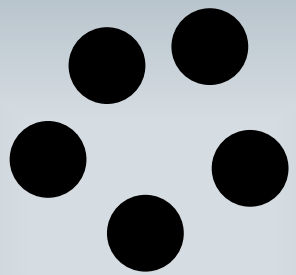


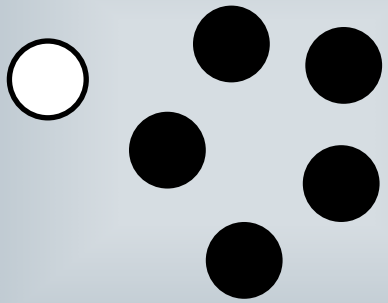
1:30PM CLASS IN SESSION – GROUP WORK

LECTURE 300 TEAM-1 300 TEAM-2 300 TEAM-3 300 PROJECTION AREA 50







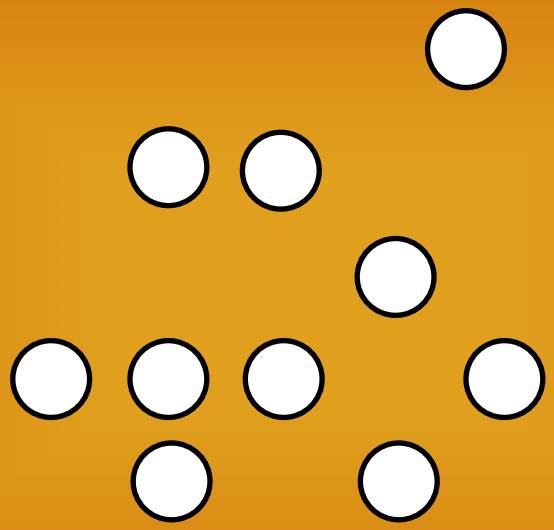


4:00PM UNOCCUPIED

LECTURE	TEAM-1	TEAM-2	TEAM-3	PROJECTION AREA
0	0	0	0	0

7:30PM COMMUNITY GROUP MEETING

LECTURE	TEAM-1	TEAM-2	TEAM-3	PROJECTION AREA
500	100	100	100	150



Lighting the Classroom of the Future

We need lighting systems where . . .

. . . the lighting matches the task needs (horizontal & vertical)

. . . the lighting matches the task areas

. . . the lighting responds to daylight and occupancy patterns

. . . the lighting color properties match user needs & preferences

. . . the lighting adjustability is easily managed

. . . the lighting quality supports desired behaviors

. . . the lighting quality reinforces desired perceptions

Lighting the Classroom of the Future

DRIVING FORCES

- Classroom lighting is a major energy use
- Classroom design is changing rapidly